DIE CASTING ENGINEER

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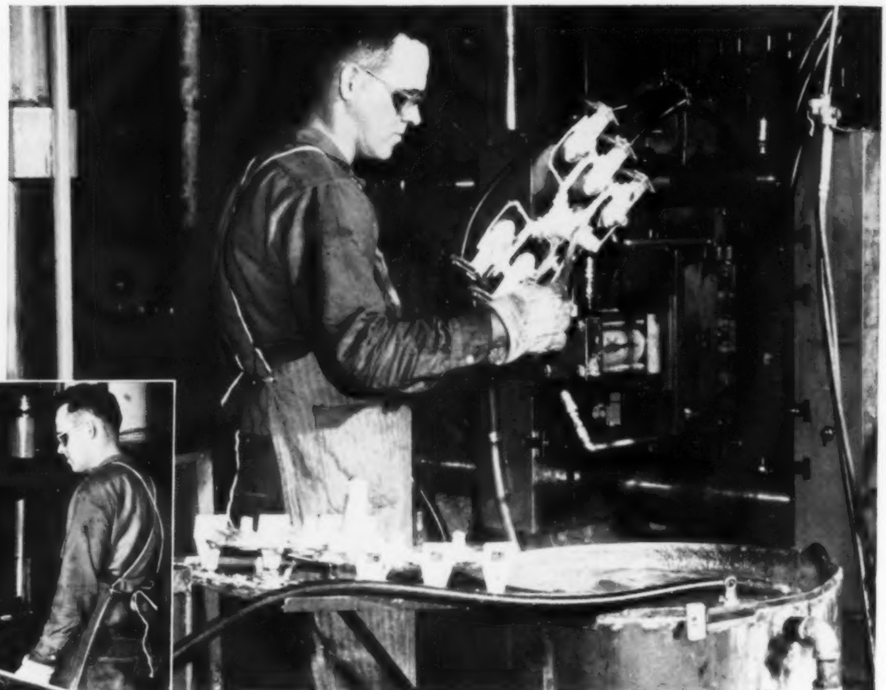
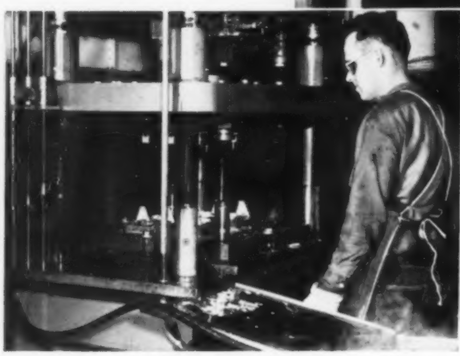
The Gating of Aluminum Die Castings





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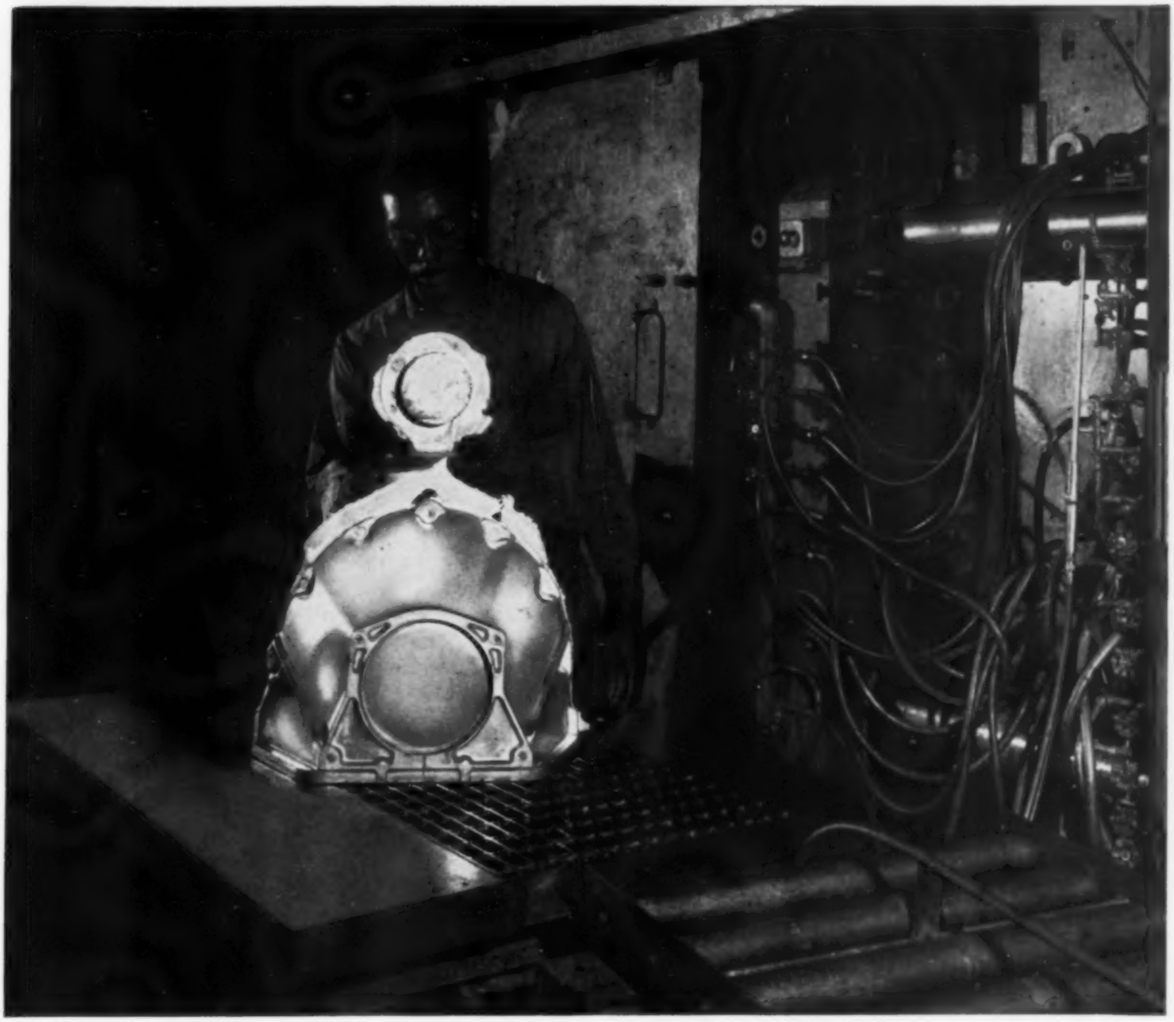
ARTICLES

DEPARTMENTS

Cover by Nick Delich



1000-ton Cast-Master at Chrysler's Die Casting Plant, Kokomo, Indiana, produces 21 lb. torque converter housings.

John L. MacLaren

PRESIDENT'S REPORT

FROM TIME to time a die caster approaches me with this question—"Why should I join the SDCE? As a die caster, I receive the *Die Casting Engineer* whether I belong or not, due to the Society's circulation policy, and I can attend monthly Chapter meetings indefinitely, if I like, as a guest."

Fortunately, this attitude is not prevalent. However, the question arises with sufficient frequency to prompt a restatement of the meaning of membership in SDCE.

The SDCE exists for one purpose and one purpose only—to assist the die caster to do his job better and more efficiently. There is no discrimination between job shops and captive shops; a die caster is a die caster regardless of his employment, and as long as he feels he can use help in his work, the SDCE will continue to serve him.

Now, how does SDCE render this assistance? There are several methods in use at present, with more to come as the organization grows and becomes stronger financially. The most effective of these is the regularly scheduled monthly Chapter meeting. Here the die caster can listen to talks presented by qualified experts on a variety of die casting subjects, and what is more important, he can ask the speaker specific questions which apply to his own operation. The die caster can offer his own thoughts on the subject and obtain the tremendously valuable advantage of hearing supporting or dissenting opinions expressed by his fellow die casters. The meeting also affords an unparaleled opportunity to talk over problems with contemporaries in an atmosphere conducive to such discussion.

There are some skeptics around who believe it unwise to permit their people to attend SDCE Chapter meetings because they might "leak" secret information which has been giving the company an apparent competitive edge. This is nonsense, for no really important secrets remain secret for long—the competition quickly finds out all about it through channels other than SDCE meetings. Moreover, if an employee die caster can be trusted anywhere, he can be trusted at an SDCE meeting.

The broad-minded approach, fortunately being adopted by more and more companies, is one of *encouraging* their die casting engineers to attend and actively participate in SDCE meetings. These companies appreciate that it is impossible to corner the market on knowledge and ideas in *any* area, let alone one with as rapid a rate of technical change as die casting, so they foster acquisition of such knowledge and ideas in every available way. One good idea picked up at a meeting, or obtained later through a friendship developed at a meeting, can repay the modest cost of SDCE membership many times over. In these competitive times we need all the help we can get in the way of good ideas to remain competitive, especially in the case of the smaller operator. In die casting, the SDCE Chapter meeting is the place to get these ideas.

The monthly meeting is by no means the only channel for dissemination of vital information to the die caster. This publication, the *Die Casting Engineer*, carries articles which are of value, and its technical content will be enlarged just as soon as advertising revenue permits. The Society also sponsors a bi-annual show whose exposition and technical congress present all that is new in equipment, supplies and production techniques. Plant visits at the Chapter level, die casting clinics, organized tours of Europe's die casting installations, work on standards—all these are activities designed to enhance the die caster's position in industry and the opportunities available to him for securing useful information. And, given the support of the industry, SDCE will insure that this list will grow.

Now to return to the question initially advanced in this column—"why bother to join?" To me it is not so much a matter of ethics as it is of good, sound, common sense and business practice. In these changing times, an organization such as SDCE is a vital source of new information of technical importance to the operation. The smart die caster doesn't withhold his support of the organization. He gladly provides as much support as he can, for it is entirely in his own interest, short-term and long-term, to do so.

A strong industry, able to meet the competition of other industries striving to furnish similar products using different materials and different processes, demands a strong technical organization to keep it up-to-date. Don't be a fence-sitter, a free-rider. Join, and join NOW!

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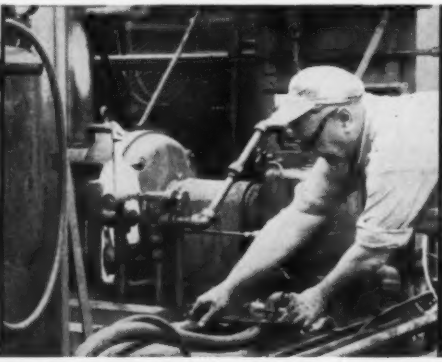

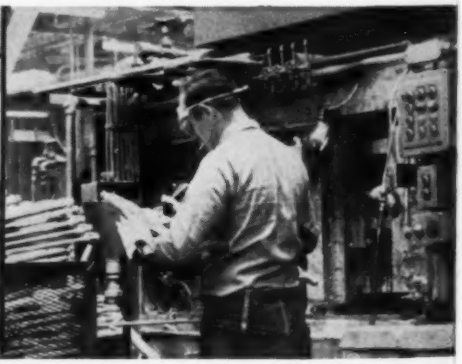

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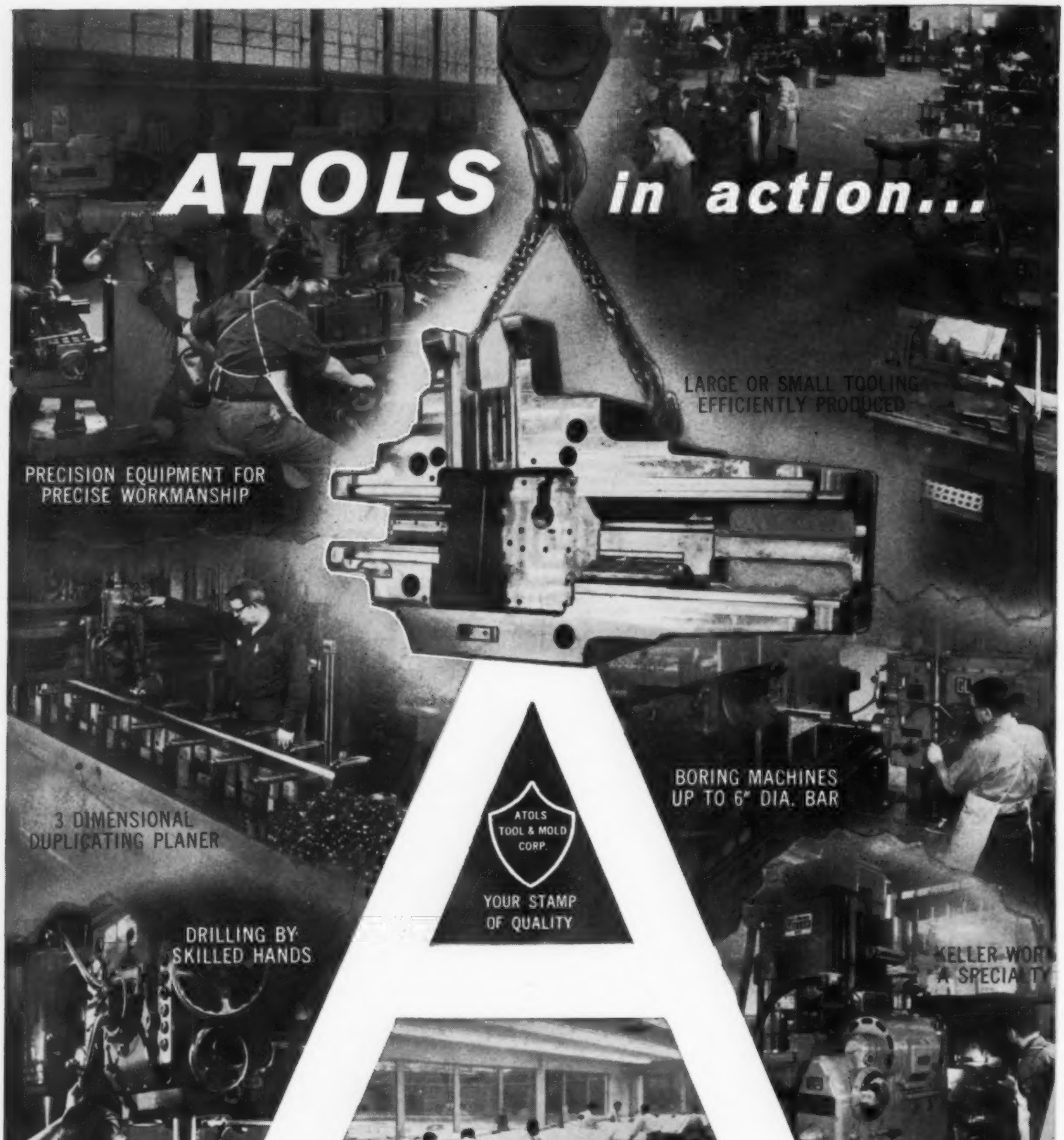
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The Gating of Aluminum Die Castings

By **H. K. BARTON**

THE GATING of aluminum alloy die castings determines, more than any other die design factor, their surface finish and structural soundness. Poor gating practice results in high scrap rates, and it may be assumed, with a fair degree of confidence, that when a component is produced with a high percentage of rejects, the quality of those castings that pass inspection is likely to be only marginally acceptable. Because of the wide diversity of form, section and complexity encountered in die cast components, the selection of an appropriate form of gate for a specific casting must necessarily be largely empirical. It is therefore difficult to generalize as to the merits of particular methods of gating, since even minor modifications in the form of the casting that is to be produced may dictate considerable changes in the position and form of the gate.

Although much attention has been paid in recent years to the gating of die castings, it has, in general, been concentrated on the determination of the required cross-sectional area of the gate rather than on its optimum position; the effects of runner form, volume, and plan area upon the efficiency of the actual gate; and the modifying effects of overflows upon the flow from the gate through the cavity. These latter factors are, however, intrinsically of greater importance than the mere cross-sectional area, for whereas the size of the gate can be progressively increased without any difficulty, assuming that the feeding method is in general satisfactory, the modification of a runner that is poorly designed may entail much welding and re-cutting. Unfortunately, these basic criteria are not amenable to reduction to a formula or a graph, and runner layout, as such, still depends upon the cumulative experience of the designer.

There is no "ideal" position for the gate of any die cast part—most castings could best be fed from a point on the under-side near the center of mass—and any position that is chosen will have some unsatisfactory features. The main value of the designer's experience is that it enables him to rule out, immediately, the totally unsatisfactory gate positions, and to mitigate the shortcomings of the least unsatisfactory position by the careful choice of runner form and the judicious use of overflows. Guidance that can most usefully be given to the less experienced designer, therefore, is of an essentially negative character. In other words, one can point out those features of gating practice which—although they are frequently seen in use—tend to result in poor quality castings and a high scrap rate.

In the present discussion, we are wholly concerned with the production of aluminum alloy die castings by conventional means. Vacuum techniques, although demanding just as much attention to correct gating practice, involve considerations that are better explored separately. Only cold-chamber methods are, of course, involved, and the gating features examined may, except where there is an indication to the contrary, be taken to relate to dies operating on modern machines equipped to give slow initial plunger movement, a variable-speed filling stroke, and an intensified final pressure.

The major difficulty in producing sound die castings is not in getting the metal into the cavity, but in getting the air out of it. In cold-chamber machines, much of the air in the shot-sleeve, as well as that in the runners and cavity, must be expelled ahead of the advancing metal if solidity is to be achieved. Accordingly, a primary aim of gating practice must be to avoid the sealing-off of vents and overflows early in the filling phase, for once this has occurred the residual air is inevitably trapped within the casting. However high the final pressure, it can only compress—not eliminate—this trapped air.

GATING ARRANGEMENTS WHICH CAUSE EARLY SEALING OF CAVITY VENTS

IF, AS is often the case, a casting is so gated that metal strikes the die surface at a very oblique angle **(Fig. 1)** and spreads in a thin stream across it, much of the periphery of the component is sealed off before more than a small proportion of the metal has been injected. The same applies when a thin-walled casting has a bead or flange of thicker section all around it. Metal flows preferentially along the thick section **(Fig. 2)** and seals off all the parting-line vents before the thin-walled areas are completely filled. The

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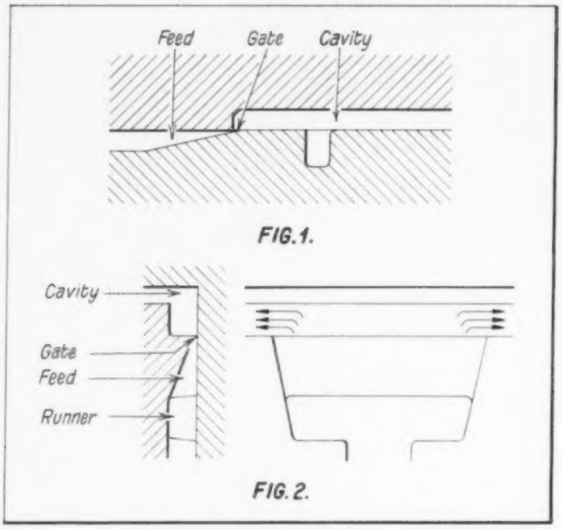

Fig. 1. Typical gate form for a flat casting
Fig. 2. When feeding into a heavy flange, metal tends to flow preferentially around the edge of the casting

fault is accentuated in both instances when runners of a spreading or "fish tail" form are adopted.

Examples of such runners are seen in **Fig. 3.** Their effect is to project a fan-shaped wavering jet into the cavity and, as they are frequently cut in such a way that they diminish in depth at each side (section *Y-Y*), flow may be extremely unstable. Metal entering the runner during the first part of the plunger stroke solidifies in the wedge-shaped extremities, so that only the central portion of the gate is initially effective. The hotter metal that follows cuts back into the chilled metal at the sides, with the result that the effective cross-section of the gate is again increased during the filling period. Control of the direction of flow within the cavity is consequently very poor, and the pattern of cavity filling varies greatly with die temperature, which determines to what extent the initial choking of the gate extremities occurs.

Some choking takes place at the ends of gates even if the section of the runner—or rather of the tapered feed—is held constant. Again, this effect is most marked with the spreading type of runner, since cold metal that has risen slowly from the shot-hole during the first part of the plunger stroke is forced outwards to the sides of the feed when the flow meets the resistance of the gate constriction. This condition can only be avoided by adopting converging, rather than spreading, runner layouts, or by extending the runner channels laterally beyond the ends of the gate to form pockets into which the chilled metal is projected.

ADVERSE EFFECTS OF CURVED RUNNERS

IN PRACTICE, these two features are often advantageously combined, but before discussing examples of such arrangements it is desirable to consider further unsatisfactory types of runner layout. A flagrant example is the carrying of a runner in sweeping curves from the shot-hole to the gate, a practice to which many draftsmen are much addicted. One such layout, seen recently on a die undergoing try-out, is sketched in **Fig. 4.**

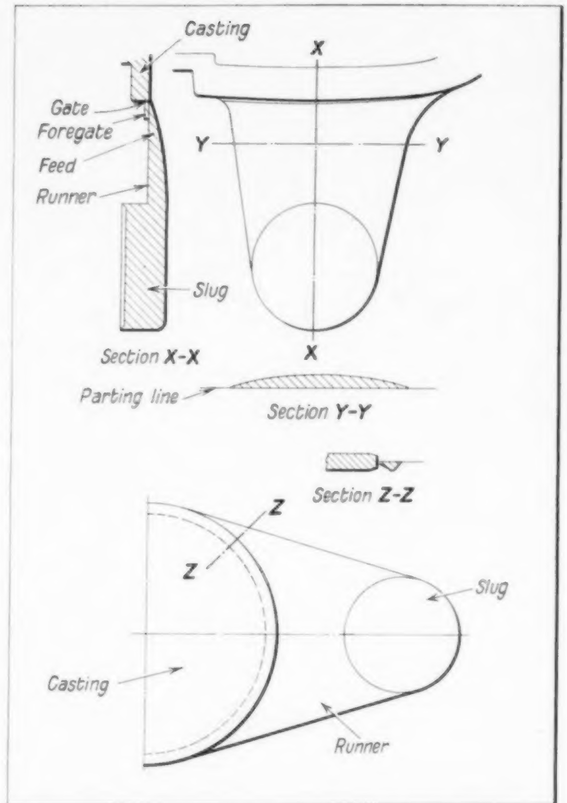

Fig. 3. A spreading runner feeding into a comparatively straight edge. The terminal flares, and the reduction of runner depth toward the sides, are particularly unsatisfactory

The die in question has two "handed" cavities for a component of approximately trapezoidal form, of such a length that the lower ends of the cavities are about level with the top of the shot-hole. As may be seen, the central portion of the runner follows a curve concentric with the shot-hole, and reverse curves con-

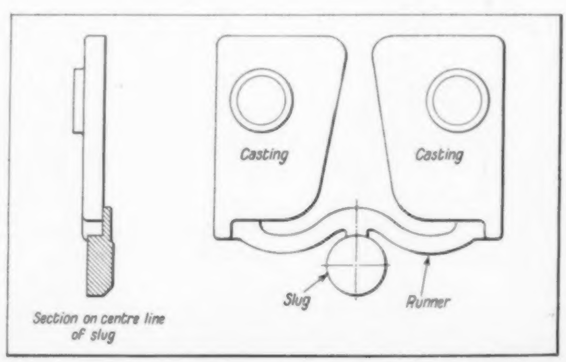

Fig. 4. This type of runner is wrongly thought to inhibit turbulence

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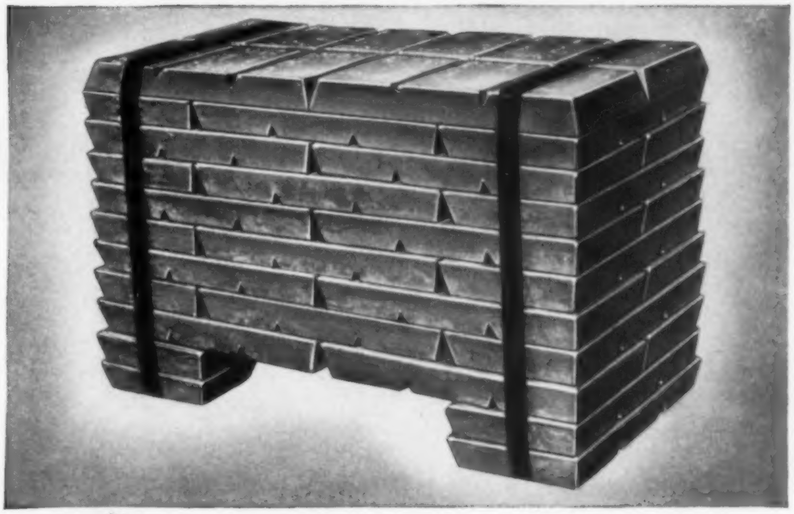

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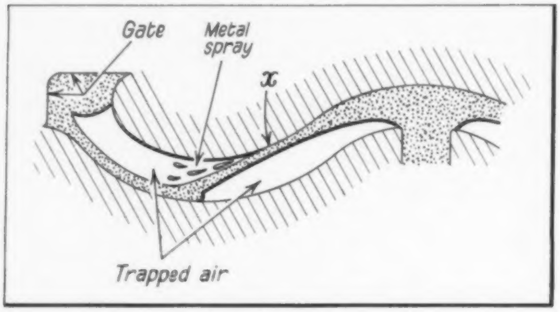


Fig. 5. Flow through the curved runner at an early phase

tinue the channels up to the fish-tailed feeds. A section through the slug is shown on the left, and it will be noted that the runner is fed from a circular depression—the depth of which is a little greater than that of the runner itself—located opposite to the shot-hole.

Such a layout has many unsatisfactory features, the most adverse being the extent to which air is initially trapped in the runner, and subsequently carried into the cavity with the metal. This trapping occurs because the metal first forced up out of the shot-sleeve is projected around the outside curve of the central portion of the runner, as indicated in **Fig. 5,** until it reaches the points *x*, where it leaves the surface tangentially to follow the outside curves of the outer ends of the runner. Not until the tapered feed sections have filled with metal backing up from the gates does the metal from the shot-sleeve begin to flow at "full bore."

Because of the velocity gradient across a curved channel—the metal necessarily flows faster on the side having the greater radius of curvature—turbulence in a curved runner is very marked. It is clear that this principle is not well understood, because one of the commonest reasons put forward to justify this type of runner is that "it makes for a smooth flow." The contrary is in fact the case, and the vorticity generated as the metal swings round the curve causes the ingestion, in the turbulent mass, of the air previously trapped. Unlike air caught up in the metal flowing along a straight channel, this air does not travel with the flow in relatively large bubbles, but is broken up into a great number of smaller ones. Moreover, because of the tendency for stagnant zones to be formed along the inner curves—the well-known "ox-bow" effect—the ingested air is not carried into the cavity all at once, but continues to enter with the metal throughout the greater part of the injection phase.

Consequently, with runners of this kind (and much more tortuous runner channels are not uncommon) it is extremely difficult to avoid gross porosity in the component. Wherever possible, therefore, runner channels should be straight and of unvarying cross section, and where a change of direction is necessary, there should be no fairing or blending of the angles of the junction. If, for example, a runner must be turned

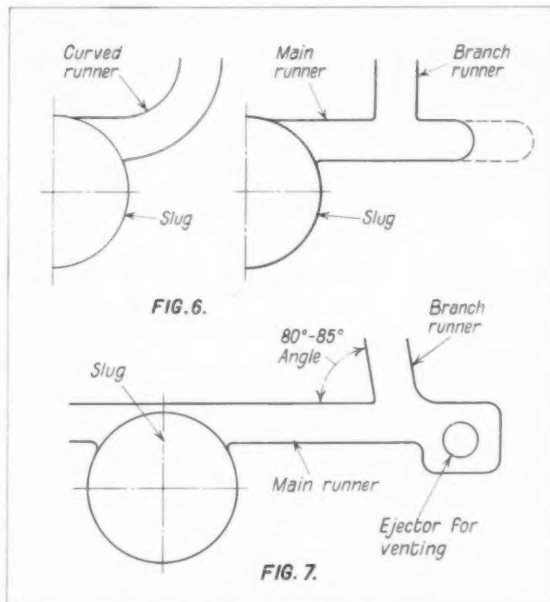


Fig. 6. When the direction of flow must be changed, the runner form on the right is preferable to that on the left

Fig. 7. To retard flow along the branch runner until the main runner is flowing full bore, the former is set at a slight negative angle, and a terminal "pressure relief" is cut at the end of the latter

through a right angle, it should not be milled to a radius as indicated on the left in **Fig. 6,** because this form results in air being trapped by the metal.

A change of direction should instead be made by carrying the main runner well beyond the point at which the turn is required, and cutting the branch runner either at right angles to it, as indicated at the right in **Fig. 6,** or at a slight negative angle, as in **Fig. 7.** The choice between the two forms depends upon the degree of pressure relief that is desirable to incorporate the runner system. In either case, the metal flowing along the main runner continues in a straight line into the runner extension, and not until this portion is substantially filled—and the back pressure consequently rises—does any quantity of metal pass into the branch runner.

The metal in the runner extension, of course, contains a large quantity of trapped air, which acts as a pneumatic shock-absorber. Initially, therefore, metal enters the branch runner at relatively low velocity, so that air is easily forced ahead of it through the gate, and it is not until the branch is running full bore that the whole thrust of the injection plunger becomes operative. When this conditon is established, and the metal begins to move with maximum velocity along the branch, a velocity gradient is certainly set up across the branch near the junction. By this time, however, virtually all the air carried in from the shot-sleeve has been expelled, so that the resulting turbulence is of no account. Indeed, the net effect may well be favorable, since any air remaining entrained in the metal is subjected to considerable centripetal stress and the bubbles move preferentially towards the stagnant or low pressure zone at the inside of the curve **(Fig. 8).**

It may appear at first sight that the same phenomenon—the establishment of a velocity gradient across the stream where it changes direction—has first been adduced as a cause of air being carried into the cavity, and then as a factor preventing air from being carried in. There is, however, no inconsistency. With curving runners static air is trapped when metal gets ahead of it, but when sharply angled runners are adopted, the

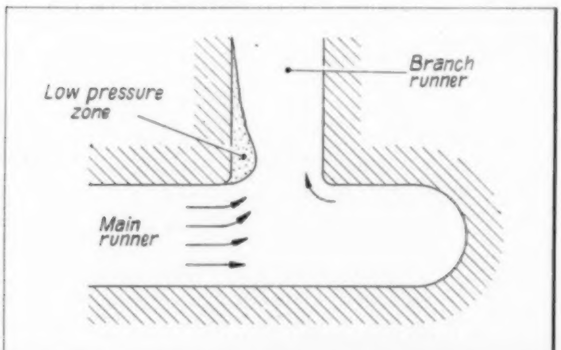


Fig. 8. The angular momentum of the metal flowing round a sharp bend induces a low pressure zone, as shown

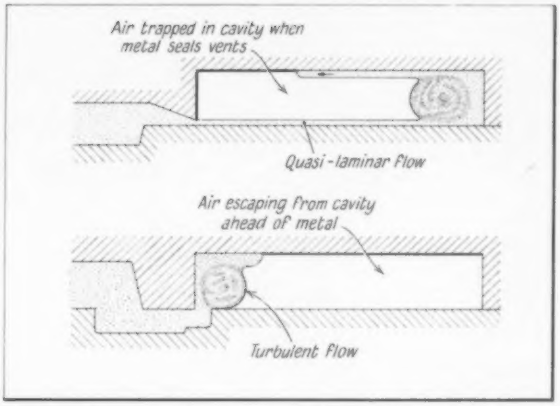


Fig. 9. Flow through a thin gate into a heavy-section cavity tends to result in the formation of a shell which then becomes filled-in from the far end. A heavier gate, placed so that the jet travels only a short distance before striking the die wall (lower sketch), results in a quick cessation of the undesirable quasi-laminar flow and the metal thereafter advances across the full width of the space between opposite die walls

static air is pushed through the channel ahead of the metal and it is only air already entrained in the metal stream that is in question. Moreover, the angular velocity of the metal is far greater when a sharp corner must be turned, so that the centripetal force upon the air bubbles is much increased.

DISADVANTAGES OF THIN GATES FOR ALUMINUM

SPREADING RUNNERS are usually justified on the grounds that by widening the feed section as its depth diminishes, the metal passage is not constricted progressively as the gate is approached. On this subject there are several comments to be made. The first is that the use of very wide and thin gates as a "carry-over" from zinc die casting practice where, although not desirable, it must in general be tolerated because it facilitates trimming. Under the very different conditions obtaining in the cold-chamber die casting of aluminum alloys—both metal temperature and injection pressure being much higher—shallow gates are much more undesirable.

When a thin gate is used in conjunction with high injection velocity, the metal is sprayed into the cavity in a pulsating, wavering stream. If this stream impinges immediately upon a core surface, overheating and erosion ensue, while if the metal is able to travel some distance tangential to the surface, as indicated in the upper sketch in **Fig. 9,** air and residual lubricant are carried with the stream into the area where the surface flow breaks down and the metal "puddles." As the turbulent mass thus formed increases in volume and moves back towards the gate, there is little opportunity for air and vapor once trapped to escape, and the unstable metal stream is continually carrying in more air.

To produce consistently sound aluminum alloy die castings, it is desirable to provide a gate of a size and

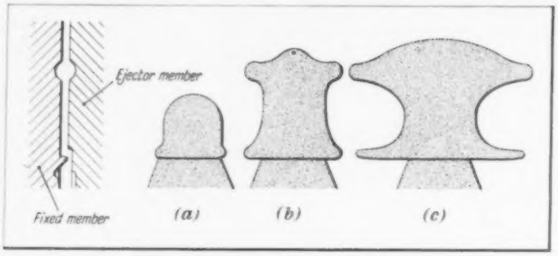


Fig. 10. Metal flow in relation to a transverse enlargement of the section.

form that will cause the metal to puddle—that is, to form a mass filling the whole cross-section of the cavity—as near to the gate itself as can be ensured (lower sketch in **Fig. 9.** This arrangement has many advantages, the foremost being that metal passing the gate (once the puddle has filled back to the gate) can not entrain additional air. Secondly, the efflux of the stream into the already injected metal reduces its velocity and modifies its impact upon adjacent core surfaces. Thirdly, the heat resulting from the loss of kinetic energy is carried, by reason of the strong turbulence immediately around the gate, outward into the spreading puddle.

As will be evident, the velocity of the metal at the advancing edge of the puddle is very much less than that of a free metal stream projected through the cavity. As the puddle increases in volume, the size and form of the gate cease to exercise a direct effect upon the direction and velocity of the metal advancing through the cavity and the gate can accordingly be considered as the point source*. The manner in which the advancing edge of the puddle spreads is primarily determined by variations in the thickness of the cavity cross-section and the local temperature of the die surfaces.

Provided that the section variations are not such that the metal can spread preferentially around the periphery of the cavity (and this can largely be prevented even in thick-rimmed dish-shaped components, by correct gating) venting at the parting-line remains effective throughout virtually the whole of the filling phase when puddle feeding is adopted. Thus, although velocity is lost—and heat gained—in the vicinity of the gate instead of remote from it as in free stream feeding, the influx rate is not appreciably reduced since the freer venting allows the air being compressed by the expanding puddle to escape more readily from the cavity and so lowers the back-pressure. Similarly, lubricant vapors, in the main, are blown out of the cavity ahead of the metal, and solid lubricant residues are not scoured from the surface and caught up in the metal, as happens when high-velocity and partly atomized jets play tangentially across a cavity surface.

The locations of gates and over-flows are highly critical even when puddle feeding is employed, for since the metal advances preferentially along the lines of least resistance—that is, generally, through the largest sections—air locks are formed if unfilled areas are cut off. Such an air lock may occur, for example, if the metal is able to advance along a pair of heavy rib impressions and merge at the far end.

EFFECT OF RIBS ON METAL FLOW IN THE CAVITY

THE ORIENTATION of ribs and other features involving local changes of section, in relation to the gate, is accordingly of primary importance. If the advancing edge meets a heavy rib section transversely, as in **Fig. 10,** the effect is to retard, momentarily, the forward movement as metal flows laterally along the rib, but the sideways movement through the thin section on the near side of the rib continues. Feeding into the rib thus proceeds on a widening front, to increase the lateral flow rate within the rib and straighten out the advancing metal front in the thin section on the far side of the rib. This effect is indicated by the sketches *a*, *b*, and *c* in **Fig. 10.**

If the advancing edge, moving through a thin section, encounters the end of a heavy rib cavity disposed radially, as in **Fig. 11,** flow again occurs preferentially along the rib, but the outward flow from the rib on both sides increases with the length of the rib filled, as shown in the figure. Whether one type of flow is to be preferred to the other depends upon the overall form of the component, and cannot be arbitrarily deter-

* Barton, H. K., "Effect of Cavity Proportions upon Metal Flow." *Machinery* (London), January 25, 1957.

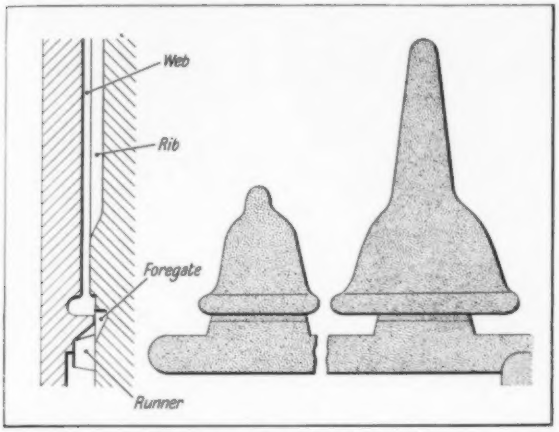


Fig. 11. The effect of a rib or bead placed in the direction of flow

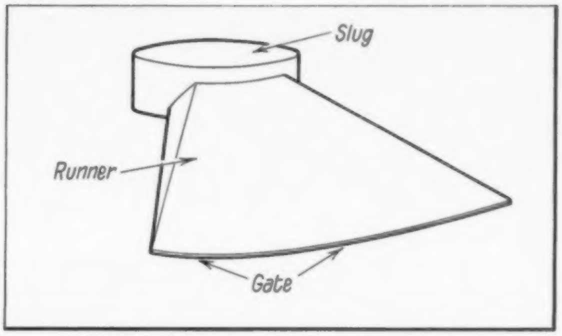


Fig. 12. Gates of this type are seldom satisfactory for aluminum alloy die castings

mined. The actual extent to which ribs and similar figures modify flow is, of course, controlled by their shapes and cross-sectional areas.

In order to prevent flow along ribs resulting in air-locks, it is desirable that the rib section should be slightly thinner than the adjoining web, and this relationship is also to be preferred on other grounds. When heavier ribs are necessary for structural reasons, they should preferably be faired off into the wall at both ends, in the manner indicated in **Fig. 11,** rather than carried to the edge of the component. Such fairing is particularly desirable if the edge of the casting has a heavy bead into which the far end of the rib would feed. However, these are points for the consideration of the product designer rather than the die designer, and the latter can obtain a satisfactory filling pattern even for components embodying unsatisfactory features by careful attention to gating and feeding.

HEAVY GATING FOR ALUMINUM DIE CASTINGS

FOR PUDDLE feeding to be achieved, heavy gating is essential. For it to be effective, correct positioning and orientation of the runner, feed, and gate are equally necessary—the two factors cannot be considered in isolation. Wide, thin gates, as in **Fig. 12,** even if correctly positioned, do not give an initial build-up of metal within the cavity adjacent to the gated portion. The metal merely changes direction and runs back along the cavity surfaces from the point of impingement, blocking the vents well ahead of the main fill.

It must be remembered that the use of a gate—in the sense of an imposed construction of the flow where the runner joins the casting—is by no means essential to the production of an acceptable die casting. Many components, even of thin section, are satisfactorily produced on Polak-type machines by direct feeding—that is, with the tapered sprue-hole opening directly into the cavity as in **Fig. 13.** The sprue metal is cut off short and, if necessary, the base is ground flush with the remainder of the casting surface. It is, how-

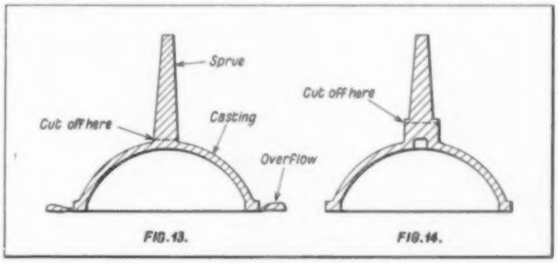


Fig. 13. Direct (Polak-type) feed into the web of a casting
Fig. 14. Feeding into a boss is more frequently adopted

ever, common for designers well experienced with such machines to revert to outside gating for a component like that shown, whereas they would have no hesitation in gating into even a shallow boss, as in **Fig. 14.** Operationally, of course, there is no difference whatever between the two castings. The solidity of Polak sprues is noteworthy and the point at which they are subsequently cut from the casting is of no importance from the cavity-filled standpoint.

There is thus no disadvantage to heavy gating apart from the increased difficulty of separating the runner-metal from the casting, and since many aluminum die castings must be hand-sawn (see **Fig. 15**) even if wide and relatively thin gates are provided, major objections can only arise when the gate form is such that all the runner metal cannot be removed with a bandsaw. Such a situation arises, for example, when an upward gate into the rim or flange of a component is adopted, on the lines indicated in **Fig. 16.** When a part gated in this way is bandsawn, a solid stub is left on the underside of the casting. For this reason, designers frequently avoid what, for many components, would be the best type of gate.

Nevertheless, it is always unwise to sacrifice casting quality for ease of trimming, and there are welcome signs that die casters are becoming more willing to mill runners from the casting instead of sawing them off. In the case of parts gated as shown in the figure, it may be an advantage to mill the whole flange surface, thus eliminating not only the band-sawing, but also any belt- or wheel-grinding operation required to remove ejector marks. On modern rotary-table equipment, with fixed cutters rotating at speeds up to 10,000 r.p.m., milling operations of this nature can be performed on several hundred parts per hour. For profile milling, to remove runner metal and fins from the edges of irregular die castings, outputs may be only slightly lower.

There is, therefore, no insuperable obstacle today to the gating of die castings in aluminum alloy with primary regard for the soundness of the casting and the speed of production achievable, rather than ease of trimming. Ease of filling, and control of the direction of flow and the rate of fill, are then the factors with which gating and runner layout are essentially concerned. Here they have been considered only in the broadest way, but at a later date it is proposed to deal with specific runner layouts and gating methods in some detail.

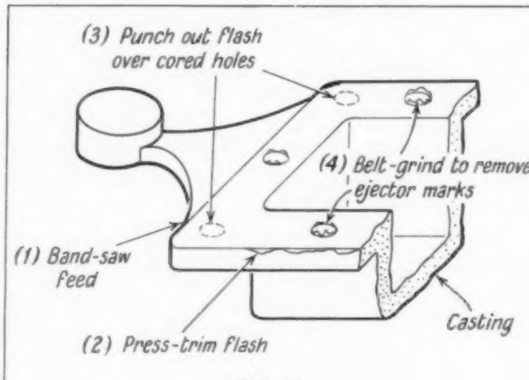


FIG. 15

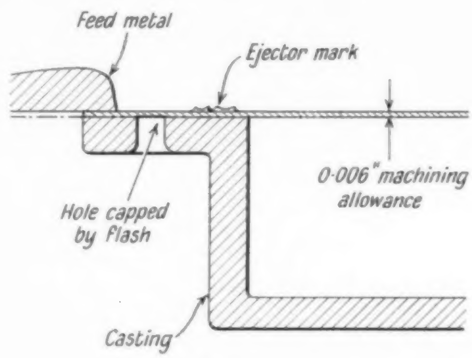
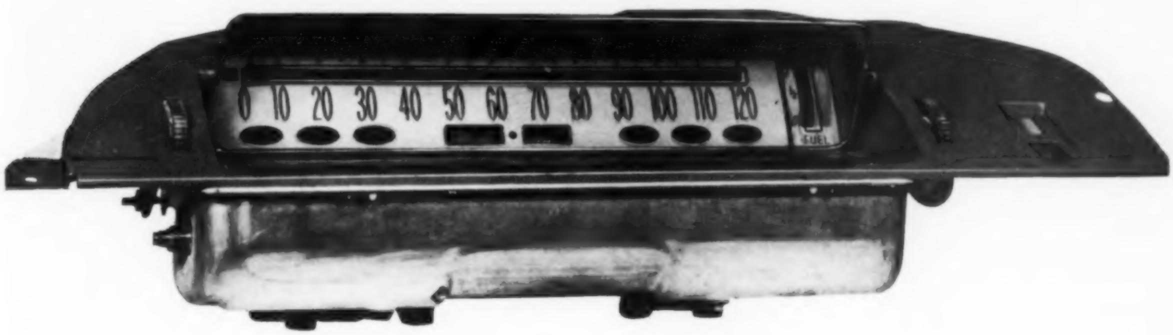


FIG. 16

Fig. 15. Four secondary operations are required on this die cast aluminum housing
Fig. 16. All four operations may be replaced by taking a milling cut all over the flange surface as shown. Milling also corrects distortion and gives improved dimensional accuracy since compensation is made for variations in flash thickness by the depth of cut taken

Why High Purity Zinc (99.99+%) Is Vital To Zinc Die Cast Products



By RALPH L. WILCOX

ZINC IS one of the few metals or industrial raw materials of any kind that can be produced with a purity of 99.99+ per cent in commercial quantities at a reasonable cost. This achievement did not just happen but came about as the result of many years of determined effort on the part of producers of zinc to supply users and particularly the die casting industry with a better product.

There are several processes for producing metallic zinc from roasted zinc ore or similar raw material. The oldest is the horizontal retort process developed in Belgium about 1806. In this process ore mixed with coal is charged into small externally heated horizontal retorts. The temperature necessary to reduce the zinc oxide to metallic zinc is above the boiling point of zinc thus producing zinc vapor. Each retort has a condenser attached to it in which the vapor condenses. The molten zinc is tapped at intervals. When the zinc has been reduced, the charge is removed. A complete cycle usually takes 24 to 48 hours.

In recent years a modern variation of the old retort process has been developed in which the ore and coal are briquetted and charged into large, vertical, externally heated retorts. The charge moves continuously down through the retort and the zinc vapor passes in a continuous stream into a condenser.

Another important method of producing zinc is by the electrolytic process. In this process the roasted ore is dissolved in sulphuric acid. The resulting zinc sulphate solution is purified and the zinc plated out by electrolysis.

In the retort process the purity of the zinc produced depends to a great extent on the impurities in the ore. In a limited way the purity of the zinc can be controlled by initially removing some objectionable impurities from the ore.

However, to produce zinc of ultra high purity (99.99+ per cent pure) required for the formulation of zinc alloys for die casting and other specialized uses, zinc produced by the retort process must be further refined by fractional distillation in a rectifying column or the zinc electrolyte in the electrolytic process must be carefully treated and purified chemically prior to deposition by electrolysis. Either process is capable of producing zinc with a purity of 99.99+ per cent.

Because it requires more effort and control to produce zinc of 99.99+ per cent purity, this quality or grade of zinc commands a premium (1 to 2¢ per pound) over the price of the ordinary commercial or prime western grade zinc in various world markets.

No one is willing to pay a premium for something better than is needed just for the sake of buying higher purity or better quality. In today's competitive markets the need for the better quality must be demonstrated beyond question.

In the case of high purity zinc (99.99+ per cent) this need has been convincingly demonstrated over the years for many applications, such as die casting alloys, slush casting alloys, forming die alloys, electrogalvanizing, special brasses and bronzes and pharmaceutical zinc oxide for use in face powders, soaps, ointments, adhesive tape and dental cement. The most important single use for high purity zinc from a tonnage standpoint is in the formulation of zinc alloys for die casting.

The production process of die casting came into use

Mr. Ralph L. Wilcox is Manager of Zinc and Silver Sales in the Sales Department of the American Smelting and Refining Company, New York City.

about the turn of the century. In this process molten metal is injected under pressure into a cavity between two closed steel dies. Speed of production and the ability to accurately reproduce complex shapes are the outstanding virtues of this process. It has been said that die casting represents the shortest distance between raw material and finished product.

Many different alloys based upon aluminum, copper, lead, magnesium, tin and zinc can be die cast successfully but the most popular and most widely used throughout the world today are the alloys based upon zinc. The reason for this being the zinc alloys represent an unbeatable combination of good physical properties, excellent castability, low melting point, ease of finishing by either plating or painting, and a moderate price.

The early zinc alloys used for die casting were none too satisfactory. The main difficulty was that while the freshly cast alloy possessed good strength this was dissipated drastically upon aging about a year or so. Aging under warm humid conditions accelerated the loss of physical properties and in addition caused considerable swelling and exfoliation with consequent warpage and dimensional change.

Years were spent in research and development work in an attempt to determine the cause of and a possible cure for this rapid loss of physical properties upon aging. Finally in 1922 it was discovered that corrosion taking place in the crystal grain boundaries was at fault. This intercrystalline corrosion started at the surface of a casting and upon aging penetrated deeper and deeper following along crystal boundaries until virtually the entire casting was honeycombed by this type of corrosion.

Intercrystalline corrosion can be likened to a wall of brick that is laid with an incorrectly formulated mortar so that upon aging, the strength of the mortar deteriorates to the point where the slightest stress will cause the wall to collapse.

Further research disclosed: (a) that the extent to which a zinc die casting alloy was susceptible to intercrystalline corrosion was dependent upon the presence of certain impurities such as lead, cadmium and tin, either individually or in combination. In fact a direct correlation was found between impurity content and degree or severity of intercrystalline corrosion, and (b) that the addition of only a small fraction of a per cent of magnesium to a zinc die casting alloy inhibited intercrystalline corrosion caused by the presence of impurities and if these could be reduced to mere trace amounts their likely harmful effect could be neutralized completely by the addition of only a few hundredths of a per cent of magnesium.

These discoveries led to the successful formulation of stable, high strength, zinc die casting alloys as we know them today. The following carefully developed specifications for these alloys have been accepted and adopted by all of the leading engineering and standards associations throughout the world.

	Alloy No 3	Alloy No. 5	Alloy No. 7
Aluminum, per cent	3.5-4.3	3.5-4.3	3.5-4.3
Copper, per cent	.15 max.	.75-1.25	.25
Magnesium, per cent	.03-.08	.03-.08	.005-.020
Iron, per cent, Max.	.100	.100	.075
Lead, per cent, Max.	.007	.007	.0030
Cadmium, per cent, Max.	.005	.005	.0020
Tin, per cent, Max.	.005	.005	.0010
Nickel, per cent	—	—	.005-.020
Zinc, Special High Grade	Remainder	Remainder	Remainder

It will be noted that the actual alloying elements are aluminum, copper and magnesium. Other elements are impurities and as such must be maintained below the specified maximum quantities in order to obtain optimum physical and mechanical properties both in the as-cast and aged condition.

In order to insure the maintenance of impurities (particularly lead, cadmium and tin) below the maximums specified for the die castings, manufacturers of die castings in turn purchase zinc alloy in ingot form to a specification that restricts lead, cadmium and tin content to individual maximums of .003% or lower.

To achieve this high purity so necessary to successful performance of zinc die castings, the alloys must be formulated with zinc having a purity of 99.99+ per cent. When this is done zinc die casting alloys have proved themselves to be sound engineering materials with excellent performance records when properly designed and applied. Their expanding use throughout the world attests to this.

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The Art Column

Die Casting, that is!

By EARLE W. REARWIN

THERE ARE many variables in the art of die casting that bedevil the die caster "artist." The art of producing quality castings using a central hydraulic system has certainly upset the tranquility of many of us.

Recently we instrumented a central hydraulic system, and learned some most interesting things as the result of the study. Through the courtesy of the firm for which this was done we have been permitted to set forth some of the facts.

As near as can be determined by comparison with plants having self-contained die casting equipment, there is a saving in power consumption when using a central hydraulic system. The initial installation cost is greater; however, once made, the additional capital cost is offset by operational savings within seven years.

Most central hydraulic systems introduce more variables into the die casting cycle than a unit system. We are aware that many "artists" will at this point raise loud objections, but wait—one must heed the instruments. They reveal many vital facts and shed light on many areas of shadow and doubt.

The designs of most central hydraulic systems do not take into consideration the special requirements of a die casting operation. The pumps and the accumulator necessary are placed at a distance from the machines. In order to produce a fast shot, the designers must specify large diameter lines from the accumulator to the machines. These lines develop a tremendous shock loading due to hydraulic surges in the system.

These shock waves were so intense that on two occasions during the tests they "blew" strain gauges. The strain gauges had a 5,000 psi limit, while the system was designed for a maximum 1,000 psi operating pressure. The shock waves were well over 5,000 psi as the instruments recorded forces of this magnitude before they "blew."

Plant operators have long lamented the hydraulic shock loading limitation inherent in most central hydraulic systems, and many attempts have been made to eliminate shock. Here is the solution reached in the case of one such installation and the results obtained.

On each machine we installed a float-type accumulator that employs a float to shut off the escape of gas or air and prevent a "blow-out" when the fluid level drops below the bottom of the accumulator. This type of accumulator is readily available and must be of sufficient capacity to make a complete shot. In the hydraulic lines supplying the accumulator, we installed a blocking valve. We closed this valve just before making each shot. This prevented any line shock from reaching the accumulator or the shot cylinder. We used a one-inch line and valve to supply the accumulator, and, of course, we made sure it was properly charged with gas in the proper ratio of gas to oil at 1,000 psi.

The lines to the machine's closing cylinder and accessory apparatus were not changed. The return lines from the shot cylinder and the machine must be left as they are or even enlarged.

No shock waves can now affect the shot, because the blocking valve has stopped them from reaching the cylinder. Of equal importance, the shock produced by the shot cannot be transmitted to the rest of the system, for the shot produced by each machine is confined to that machine.

Now let us look at the results as indicated by the instruments. The pressure system is at a constant level and free of shock. No shock waves are recorded except when the machine closes, and these are minor. Each shot made by the machine is exactly the same in character as long as the accumulator is charged. This condition is easily maintained over prolonged production periods, permitting constant, reliable machine performance. Plunger speeds and pressures are constant and the resultant castings are uniform. With this type of alteration it is possible for a central hydraulic system to offer the operating economies of such a system without the customary drawbacks.

Another art, that of guessing the effect of shock waves on the castings, has thus been moved from the status of an art into the status of a scientifically controlled factor in the production sequence.

DCE LETTERS

Sliding Core Pins

We would like to have your advice on the best material, and any important points of manufacture, for the small diameter ($\frac{1}{8}$ inch to $\frac{3}{16}$ inch) sliding core pins—that is, the pins which actually produce the core hole in the casting.

We have been using silver steel and have also tried high speed steel and cast steel. However, we do get the pins breaking down after a time which immediately follows the necking down of a portion of the pin. The requirement is, of course, a tough but unbendable pin which will stand up much more reliably than those that we have been using.—C. A. D.-P.

This inquiry was passed along to one of our members in this line of business, and was answered by sending specifications of core pins made of the finest grade of hot-work die steel, which have proven themselves under the severest conditions.

SDCE NEWS

NEW CHAIRMAN OF SECOND NATIONAL EXPOSITION CONGRESS

THE NATIONAL Directors of the Society deeply regret to have to announce the resignation of Mr. David Tann as Chairman of the Second National Die Casting Exposition and Congress, to be presented in Detroit's Cobo Hall under Society sponsorship September 25-28, 1962. Mr. Tann, named to this important position in the September issue of *Die Casting Engineer,* has resigned for compelling business reasons which would preclude his active participation in show arrangements.


H. M. EGER

The Society has been fortunate in obtaining the services of Mr. Harold M. Eger, President of Harold M. Eger & Associates, Dearborn, Michigan, as new 1962 Show Chairman. In this capacity he will direct all planning for the Industry Exposition, expected to attract 10,000 visitors from all over the world, as well as the Technical Congress, featuring papers on subjects of importance to die casters and castings buyers.

Mr. Eger majored in aeronautical engineering at the Universities of Michigan and Toledo and, prior to World War II, held production and sales positions in the industrial furnace and steel industries.

Following four years in the U.S. Army he established his own company to perform production engineering and sales representation services in the eastern Michigan area. Among the product lines sold to the automobile industry are die castings, screw machine parts and cold headed items.

CHANGES IN SDCE BY-LAWS

AT THE October 6, 1961, National Board of Directors meeting held at Cleveland, Ohio, a number of changes were made in the Society's By-Laws, as revised February 17, 1961, in the interest of strengthening the Society through selection of the most qualified candidates for the leadership positions.

Briefly, the changes involve increasing the number of vice presidents elected annually from one to two, and vesting the Board of Directors with responsibility for annual election of the National President, Vice Presidents, Secretary, Treasurer, and Director at Large.

The specific changes, which were adopted unanimously by the Board, involved rewriting certain sections of Articles VI, VII, VIII and XI, as listed below. It is expected that the new procedures will guarantee filling critical positions with persons of known ability, thus assuring the Society a solid basis for continued growth.

BY-LAW CHANGES

ARTICLE VI

Section 2

The Board of Directors shall be comprised of the President, the First Vice President, the Second Vice President, the Secretary, the Treasurer, the two immediate Past Presidents, three Directors at Large elected by the Board of Directors for a term of three (3) years, and one Director from each active Chapter elected by that Chapter for a term of two (2) years.

ARTICLE VII

Section 1

The officers of the Society shall consist of the President, the First Vice President, the Second Vice President, the Secretary, and the Treasurer.

Section 4

The Vice Presidents in their order shall perform the duties of the President in the absence of the President or when the Board of Directors shall verify the inability of the President to act. The Vice President shall also perform such other duties as provided in these By-Laws or assigned him by the President or Board of Directors. In the event a vacancy occurs in a national office, this vacancy shall be filled by election by the Board of Directors for the balance of the term of office.

ARTICLE VIII

Section 1

The Director at Large, the National President, the

First Vice President and the Second Vice President shall be elected by the Board of Directors by written ballot on or prior to December 1 of each year. The Secretary shall immediately notify each candidate and each chapter, in writing, and shall cause results to be published in the Official Publication. The incoming directors and officers so elected shall automatically assume office January 1 of the year of their tenure in office.

Section 2

The term of office of the President and Vice Presidents shall be one (1) year.

Section 3

The Directors at Large shall be elected by the Board of Directors for a term of three (3) years. One Director shall be elected each year to serve a three-year term. In the event of a vacancy among the Directors at Large, the Board of Directors shall elect a Director to fill the unexpired term.

ARTICLE XI

Section 2

The National Officer Nominating Committee shall prepare a ballot for submission to the Board of Directors covering each elective office. This ballot shall be presented to each member of the Board at least twenty (20) days prior to election.

NATIONAL OFFICER NOMINATING COMMITTEE

AS PROVIDED in Article XI, Section 1 of the By-Laws of the Society of Die Casting Engi-

neers (as revised February 17, 1961), a National Officer Nominating Committee has been appointed to name candidates for the 1962 calendar year for the offices of President, First Vice President, Second Vice President and Director at Large for the Society's national organization.

The Chairman of this Committee is Joseph R. Elkins, J. R. Elkins, Inc., Brooklyn, New York. Committee members are Lee G. Axford, Engine and Foundry Division, Ford Motor Company, Dearborn, Michigan, and Francis E. Kennedy, Kennedy Die Castings, Inc., Worcester, Massachusetts.

OBITUARY

William Austin Darrah, Vice President, Lindberg Engineering Company, Chicago, died in his home after a long illness.

He was founder of Continental Industrial Engineers, Inc., which merged with Lindberg to form one of the world's largest manufacturers of industrial heat treating and process line equipment.

Mr. Darrah had wide experience in the United States patent office as an assistant patent examiner and was a registered patent attorney in the United States and Canada.

Prior to the formation of Continental Industrial Engineers, Inc., Mr. Darrah directed research work at Western Electric Company in the division which is known now as the Bell Telephone Laboratories.

CHAPTER NEWS

DETROIT

1 Both the October and November meetings of the Detroit Chapter of the SDCE featured fine speakers and excellent attendance.

Mr. Don Welter, Safety Director of the Guide Lamp Division, General Motors Corporation, made a stimulating speech in October on "Safety in the Die Casting Department." Some 93 interested die casters and guests assembled at the Glen Oaks Country Club in November to hear Glen Carlson, Acme Manufacturing Company, deliver an informative talk accompanied by a movie on "The Automatic Finishing of Die Castings."

—Robert Smith, Correspondent

SAGINAW VALLEY

2 An unusually large number of members of the Saginaw Valley Chapter attended a dinner meeting at the Ternstedt Division of the General Motors in Flint, Michigan, on Wednesday, November 15. Following the dinner, the SDCE members and their guests took a plant tour of the Ternstedt Division. Such plant tours always attract die casting engineers and make the most popular kind of meeting.

—Robert L. McKee,
Secretary-Treasurer

WESTERN MICHIGAN

3 Die casters of the Western Michigan chapter and guests met in October in Grand Rapids to see the movie "How Else Can You Make It." The Chapter accepted with regret the resignation of Jay Petter as National Director, whose new duties will take him out of the area. Don McLean, Chapter Chairman, has assumed the position for the balance of the term.

The Western Michigan Chapter extends a cordial invitation to the many die casters in the St. Joseph-Benton Harbor area to attend their meetings.

—Carl Neuendorf, Correspondent

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Charles Zapf & Co.

TOLEDO

4 Members of the Toledo Chapter and many visiting members of SDCE were fortunate to be guests of the Chevrolet Passenger Transmission plant in November for the tour of the plant facilities. Some 60 people had dinner at Angelo's Spaghetti House before enjoying a visit to one of the larger die casting operations in the United States.

—David Klotz, Correspondent

CLEVELAND

6 An especially large turnout marked the October and November meetings of the Cleveland SDCE at Harry Manolen's Restaurant. In October the chapter eagerly listened to Don Colwell, Vice-President, Apex Smelting Company, speak and show slides on "Melting of Aluminum for Die Casting." Alfred Mason, the guest speaker in November, discussed "The Control of Variables in Die Casting."

The proposed slate of officers for the chapter for 1962: Chairman, William F. Joseph, Rossborough Supply Company; Vice-Chairman, Robert W. Miller, Westinghouse Electric Company; Secretary, E. J. Hinkel, Mik-Su Machine Inc.; Treasurer, L. R. Wadsworth, Braeburn Steel Company; Trustees, James Christopher, Tool Die Engineering Company; Harry Cagin, Halex Die Casting Company; James Milidonis, White Industries; David Morgenstern, Nelmor Mfg. Company; James Drylie, Westinghouse Electric; National Director, David Morgenstern; and Alternate National Director, James Drylie.

—E. J. Hinkel, Correspondent

NORTH CAROLINA

15 Mr. J. R. Elkins, President of J. R. Elkins Inc., presented a two-fold talk regarding the value of SDCE to each member and "Economizing in the Die Casting Industry" at the October meeting of the North Carolina Chapter.

Mr. Don Linderman was selected to fill the office of Chairman which became vacant when Mr. Wayne Wessendorf accepted a position with a company outside the Chapter territory.

—William Lord, Correspondent

INDIANA

25 The November meeting of the Indiana Chapter produced a record turnout of 91 die casters and guests who came for the turkey dinner and technical session held at the Elk's Club in Anderson.

John Lapin, Fabricast Division of General Motors, moderated an audience participation program involving injection and molding pressures. The discussions were provocative and lively.

The next meeting of the Chapter will be Ladies Night at the Casa Grande in Kokomo on December 15.

—Gene Vierling, Correspondent

INDUSTRY NEWS

LAKE ERIE-MORTON VERTICAL DIE CASTING MACHINE

A BREAKTHROUGH for complete automation in the die casting industry was disclosed by John M. Wolf, Vice-President and General Manager of Lake Erie Machinery Corporation of Buffalo, a subsidiary of Bell Intercontinental Corporation.

A new die casting machine of the vertical type, built and designed in conjunction with Morton Manufacturing Company, Inc., of Omaha, Neb., utilizing Glenn R. Morton's invention, the Thermal Feed Tube for automatic ladling under vacuum, has been installed and is now operating at the Morton plant. This is the first commercially marketed unit of this type, Mr. Wolf stated.

"The design," Mr. Wolf said, provides a wide variety of advantages over any other available equipment. Such inovations as vertical straight fall ejection, automatic part unloaders, automatic die lubrication and air jet flash removing, have virtually assured the accomplishment of complete die casting automation.

"In addition, the use of a vertical unit reduces floor space requirements by 60 per cent as compared to the traditional horizontal units. This is of considerable importance to most plants in the expanding die casting industry," Mr. Wolf said.

Designed for aluminum, zinc and other usual non-ferrous metals, the unit's automatic ladling feature and vertical position can reduce tonnage requirements up to 50 per cent and more in some castings, according to the Lake Erie Machinery executive.

D-M-E

In order to provide a maximum of cavity area in the smaller zinc die cast dies, D-M-E Corporation, Detroit, Michigan, has developed and is now marketing a new pair of small standard sprue spreaders and mating bushings. Intended for use in dies where space is a highly important factor, the sprue spreader body diameter measures only 1½ inches while the sprue bushing O.D. is only 2½ inches.

KOZMA

A new line of pot-type melting furnaces has been introduced by J. A. Kozma Company, 2471 Wyoming, Dearborn, Michigan. The new Series NF furnaces are specifically engineered for melting and holding zinc, magnesium, lead, and Kirksite, as well as other nonferrous metals.

Recommended uses are: alloying and holding furnaces for die casting; melting furnaces for aluminum foundries; reclaiming furnaces for smelters; and, as permanent mold re-melt and holding furnaces.

PERMANENT MOLD DIE

A new four-cavity universal automatically-cycled permanent molding machine for producing pistons up to 2¼ inch in diameter and at rates up to and exceeding 240 per hour is available from Permanent Mold Die Company, 2275 East Nine Mile Road, Warren, Michigan.

GUIDE LAMP

SDCE is happy to announce that Guide Lamp Division of General Motors Corp., Anderson, Indiana, have become Sustaining members of the Society with Company representatives: Messrs. John E. DuPouy and Floyd Crosley.

The Society appreciates this support of its objectives and ideals displayed by Guide Lamp.

1962 AUTO GRILLES, LIGHTS USE MORE DIE CAST ZINC

IN TODAY'S fluctuating automotive marketplace, where such diverse materials as chrome plated zinc die castings, aluminum stampings, and plastics moldings frequently compete for the same part, zinc men are pointing to a 1962 trend in three major component areas as an index of their metal's healthy position in this industry. Comparing materials used for grilles, head and taillight assemblies during 1962 against usage for the same application in 1961, zinc is clearly making significant gains.

A survey of 23 basic 1962 models manufactured by the five leading automotive producers tallies an impressive 29 gains for zinc in these three areas, reports American Zinc Institute. Included are 7 complete conversions from either aluminum or plastics to die cast zinc designs. These replacements consist of grille changes (Buick Special), headlight assemblies (complete standard size Oldsmobile line as well as the F-85 and the Buick Special), and taillight assemblies (Buick Special, Oldsmobile F-85 and Comet).

Of substantial importance to zinc suppliers is the redesign of die cast zinc components where the part is now larger than last year's version. For example, more zinc goes into the all-zinc grilles on the 1962 standard-size Pontiac, Buick, and Oldsmobile models, than used last year. Die cast zinc headlight assemblies on the standard-size Pontiac, Buick, Mercury, and Cadillac are also heavier.

Die cast zinc taillight assemblies are responsible for a healthy zinc consumption increase this year, with standard-size Pontiacs, Buicks, Oldsmobiles, Mercurys, Plymouths, Dodges, and Chryslers, sporting larger units. Mercury's 1962 Comet uses a die cast zinc taillight assembly, compared with a plastic design last year. Other gains for zinc have been made in a number of these components where 1961 aluminum designs have shifted to a combination of zinc and aluminum.

Zinc men say that the swingback is unavoidable. They point to the ease with which their metal can be die cast into the most intricate of shapes, the ready maintenance of dimensional tolerances with only minor secondary finishing operations, as well as significantly improved plating finishes with multiplied corrosion-free service life—as some of the basic reasons.

John L. Kimberley, executive vice president of American Zinc Institute, notes that car makers have been increasing their per unit use of zinc for a number of years. The 1962 models are scheduled to carry 10% more zinc than the 61's, he reports, with full-size models averaging 80 pounds compared with 75 in '61. The compacts will be increasing their per unit consumption of zinc from 30 pounds to to 35. Kimberley points out that the increases reported in grilles, head and taillight components are representative of zinc gains made across the board in 1962 models.

"When new materials enter the industrial marketplace, it is natural that they will receive fresh atten-

tion from enterprising producers," said Kimberley. "And such attention is intensified when massive promotional efforts are marshaled to launch a newcomer," he declared. "However, the final selection must be made on a basis of performance," he said. "We in the zinc industry are confident that the automotive industry's continued and growing reliance on our metal bears out our own conviction that we have a material offering a unique package of assets that cannot be overlooked."

NEW LITERATURE

AMERICAN Smelting and Refining Company have reworked their manual "Die Casting with Zinc Base Alloys," which is designed to guide die casting machine operators by presenting some of the fundamentals of the process and practical hints for making good zinc castings. Companies or individuals wishing to obtain copies of this useful manual for distribution to their operators are requested to communicate their requirement to Mr. Ralph L. Wilcox, Manager, Zinc and Silver Sales, American Smelting and Refining Company, 120 Broadway, New York 5, New York.

MFG. RESEARCH BROCHURE

A new 14-page brochure on Manufacturing Research and Engineering has just been released by Designers for Industry, Inc., 4241 Fulton Parkway, Cleveland 9, Ohio.

Copies of the brochure may be obtained by writing the Manufacturing Systems Div., Designers for Industry, Inc., 4241 Fulton Parkway, Cleveland 9, Ohio.

TRIG, LOG, ANTILOG, AND LOG OF TRIG FUNCTIONS 6 PLACE TABLES

It's almost unbelievable, but all the tables listed in the above title are in this handy (2⅝ by 5⅝) compact (192 pages) Vest-Pocket Library Book.

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Inquiries may be sent to Ottenheimer Publishers, Inc., 4805 Nelson Avenue, Baltimore 15, Maryland.

UDYLITE

New Udylite literature completely describes the modern design, features and components of the Ultrasil Rectifier line. Profusely illustrated with photographs, charts and tables, the 12 pages provide detailed information on control elements, unique diode assembly, rheostats, switches, transformers, etc. Write to The Udylite Corporation, 1651 E. Grand Blvd., Detroit 11, Michigan.

ATWOOD BRASS

Atwood Brass is opening a die casting facility in a new plant at Lowell, Michigan, with Mr. Ed Ward as plant manager. Mr. Tom Mainsinger, Atwood Chief Engineer, says they have two die casting machines and the newest and best in plating equipment.

LINDBERG STEEL TREATING CO.

Lindberg Steel Treating Co. has announced the promotion of Michael J. Wilms to sales manager of the company's headquarters plants located in Melrose Park, Illinois. Mr. Wilms is a member of The Society of Die Casting Engineers.

People in Die Casting

AZI

Ernest W. Horvick has just been named Director of Technical Services for American Zinc Institute, reports John L. Kimberley, executive vice president of the Institute.

A member of AZI's market development staff for the past nine years, Horvick will have a primary responsibility for the technical aspects of the Institute's services, in relation to market development and sales promotion, Kimberley said.

D-M-E

Frank Saller has been appointed to the sales staff of D-M-E Corporation, it was announced by L. J. Morrison, vice-president in charge of sales. Prior to joining D-M-E, Mr. Saller was associated in various capacities with the tool and die making industry in the Midwest area.

His background and knowledge in the field of die cast die construction will be of valuable assistance to die makers in Indiana, Illinois and northern Kentucky.

LINDBERG ENGINEERING

Cary H. Stevenson, Vice President of Lindberg Engineering Company, Chicago, has announced the recent appointment of Elmer W. Edstrand as Manager of Lindberg's Kiln Division.

SUPERIOR DIE CASTING

Formerly with Precision Castings, Arnold N. Chemlik is now associated with the Superior Die Casting Company in Cleveland.

BUSS MACHINERY

Mr. Jay C. Petter is now associated with the Woodworking Division of Buss Machinery Company.

LATROBE STEEL

Harold C. Burgess, Cleveland district sales manager for Latrobe Steel Company for the past 21 years, rounded out 25 years of service when he retired in September.

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